



Quarterly

Missouri Department of Transportation

Vol. 2, No. 3

Missouri roads rated in top ten

The overall performance of the state highway systems across the country continues to improve, and mid-western, western states, and southern states continue to dominate the top ten

places. These trends were announced in the seventh annual study of cost-effective highway performance just released by University of North Carolina/Charlotte's Center for Interdisciplinary Transportation Studies.

The top ten rated highway systems for 1996, the latest year available, were: 1-Wyoming, 2-South Carolina, 3-North Dakota, 4-Idaho, 5-Nebraska, 6-Utah, 7-Texas, 8-South Dakota, 9-Montana, and 10-Missouri.

The five measures of fiscal performance examined were administrative costs, maintenance costs, road and bridge capital costs, total disbursement, and total receipts. Seven system performance criteria were used: pavement condition for rural interstates, urban interstates and rural principal arterials, urban interstate congestion, deficient bridges, fatal accident rates, and rural principal arterial land widths.

Reprinted from "Highway Performance", *Better Roads*, August, 1998.

Intelligent Transportation Systems

Missouri Summary

Major Metropolitan Areas

St. Louis - An ITS Early Deployment Study for the St. Louis area was completed in April 1994 and a Strategic Deployment Plan was included as part of the final report. Initial elements of the strategic plan are currently being implemented under the guidance of an Incident Management Coalition which was organized in 1993. The first project includes expansion of the Motorist Assist Program (freeway service patrol), establishment of a cellular call-in system, a roadway reference marking system, an improved communication system between MoDOT and local jurisdictions, and operation assistance for a Traffic Information Center (TIC). Design contracts are also underway for the development of the TIC, the operational software for the ITS system and phase I of the field equipment installa-

tions. Final right-of-way clearance has been obtained for the property on which the TIC will be located. The TIC will house MoDOT Traffic personnel as well as consultant management personnel and construction is expected to begin in late 1998. The location and design of field devices (variable message signs, cameras, traffic detection equipment) and the associated communication network facilities are currently being completed under a consultant contract. The system is being implemented in phases and has a total estimated cost in excess of \$12 million with 80% Federal-aid participation in CMAQ funds. To date \$4.2 million in CMAQ funding has been obligated.

Kansas City - In order to assess transportation needs and identify user services for implementation, an ITS Early Deployment Study was completed in February 1996 for the Kansas City area. This study produced a Strategic Deployment Plan which

documents the transportation system characteristics in the Kansas City metropolitan area, ITS user services appropriate for application, a system architecture, alternative technologies available, and an implementation plan. Coordination efforts between KDOT and MoDOT are continuing for initial implementation of ITS elements in the Kansas City area, including a joint

(continued on next page)

Inside:

Briefs:

Missouri Completes First Performance Concrete Prestress I-Girder Fabrication

Fiber-reinforced PCC Unbonded Overlay

Longitudinal Restraint Response of Existing Bridge Bearings

All-American Shouldering Disc

(continued from page 1)

(MoDOT/KDOT Traffic Operation Center. On July 22, 1997, the ITS Partnership Agreement between the MoDOT and FHWA was executed and the \$2.5 million in additional funding provided by the FY97 appropriations bill for ITS development in the Kansas City area was obligated. This will help to implement Phase I of the ITS Strategic Deployment Plan which provides for ITS elements on 77 kilometers of Interstate highway. Design of Phase I has been initiated under a consultant agreement. An additional \$1 million has been provided in the FY 1998 Appropriations Act for this project to provide intermodal common communications technology at the Richards-Gebaur Airport site.

Springfield - Through a cooperative effort between the City of Springfield and MoDOT, a Traffic Management Center (TMC) has been developed which is jointly managed and operated by both agencies. The initial phase of this project included the installation of signal controllers which utilize the same software to insure a seamless communication network. The ITS facility includes a 29-kilometer fiber optic communication network, interconnection between 150 traffic signals and the TMC, MoDOT, and City facilities, and 16 CCTV cameras to monitor 40 intersections. Real-time traffic information from the TMC is also available to the media, governmental agencies, emergency service providers, and Internet users. The TMC is located in an educational and hands-on museum called the Discovery Center. Visitors are able to view CCTV monitors, observe the TMC in operation, and individually operate a demonstration camera to better understand the capabilities of the system. In support of National Transportation Week, the City of Springfield held an event called "Transportation Days" on May 21-23, 1998. As part of this event, on May 22, a special ribbon cutting ceremony was held for the new Traffic Management Center. FHWA participated in this ceremony and commended the significant accomplishment of this partnership effort.

ITS Innovative Finance Project

MoDOT is proceeding with implementation of a statewide Intelligent Transportation System and installation of the fiber optic communications network under the public-private partnership with Digital Teleport, Inc. Approximately 2414 kilometers of the 2736 kilometer fiber optic system have been installed. The value of the fiber optic system has been recognized under the FHWA Innovative Finance program and a \$30 million soft match credit was approved by Administrator Slater on October 23, 1995 for use on future ITS projects. To date, \$1,525,180 of the soft match has been utilized to help advance ITS projects in Missouri.

Branson TRIP (Travel and Recreational Information Program)

The proposal submitted by MoDOT to the FHWA nationwide solicitation for an ITS operational test site for traveler information services in tourism areas was selected for funding in October, 1997. MoDOT was awarded \$600,000 in ITS funding for the Branson Travel and Recreational Information Program (TRIP). The project objective is to collect, coordinate and disseminate travel, tourist, recreational, entertainment and weather information through an integrated traveler information system which is intended to improve mobility, reduce congestion, enhance economic development and improve the experience of visitors to the Branson area. MoDOT is leading a group of more than 15 public and private partners in this effort to address the traveler information needs of Branson tourists. The information is being provided through media such as the Internet, dial-in telephone services, variable message signs, commercial radio and cable television. This project is the first step in the development of an Advanced Traveler Information System (ATIS), which is planned to eventually operate in Missouri, Arkansas, Oklahoma, Kansas, Nebraska and Iowa. The total project cost is \$1.4 million with private partners providing over 30% of the funding. In a special ribbon cutting event on June 1, 1998, the Branson Travel and Recreation Infor-

mation Program (TRIP) was launched into operation. As part of the ribbon cutting, MoDOT also announced the Branson TRIP website:

www.branson.tripusa.com which provides the consolidated information in a user friendly way. The system is being evaluated during the peak tourist season for its utility and effectiveness in meeting traveler information needs

Road Weather Information System (RWIS) - Operational Test

Four Departments of Transportation, including Iowa, Missouri, Illinois, and Wisconsin, along with the private sector, have formed a public-private partnership called FORETELL to integrate ITS with advanced weather systems to enhance highway maintenance management and traveler information. FORETELL submitted a proposal in response to FHWA's request for participation in the development and operational testing of a weather information system for surface transportation. In October, 1997, the FORETELL proposal was selected to receive \$1.3 million in funding from FHWA to implement an integrated road weather information system that improves the scope of atmospheric and road surface condition information available to highway users. This project will be the initial step in implementing an integrated RWIS across North America. The total estimated cost of this project is \$4.5 million and the additional funding will be obtained from sources developed in the public-private partnership. MoDOT participated in a kick-off meeting which was held on November 12-13, 1997. Implementation and evaluation of the operational test system is to begin in the fall of 1998.

Heartland ITS Forum

MoDOT has participated in the formation of a group for ITS professionals called *Heartland ITS Forum*. This group is fashioned after ITS America chapters in other areas of the country and is intended to facilitate information sharing about ITS projects and activities and to showcase ITS applications in FHWA Region 7. To date four State

Departments of Transportation including, Missouri, Iowa, Kansas and Nebraska, along with the FHWA and Iowa State University have been involved and are working together to develop the organization. Potential benefits of membership in the forum include information exchange, education opportunities, project coordination, creation of public-private partnerships, access to future customers and sharing of existing and future research. Heartland ITS Forum plans to hold an annual meeting to allow members to discuss ITS issues, learn about activities in other states and have vendors showcase new products. Organizers of this group are currently collecting information to pursue formal affiliation with ITS America.

MoDOT Wireless Telecommunications Shared Resources Policy

On September 26, 1997, MoDOT issued a Request for Proposal (RFP) for a shared resources public-private partnership with the telecommunications industry to support deployment and operation of the Intelligent Transportation System (ITS) in Missouri. MoDOT has recognized the developing market for wireless telecommunications systems and adopted a Policy on Wireless Telecommunications Shared Resources in January, 1997. Telecommunications firms which are seeking to initiate or expand services in Missouri may identify sites for their wireless infrastructure on MoDOT right-of-way (ROW). MoDOT will allow placement of this infrastructure where mutually acceptable sites are identified on MoDOT property in exchange for goods and services that support ITS deployment and operation. Property to be considered includes sites along the highway ROW, rest areas, maintenance yards and weigh stations. MoDOT has made a commitment to proper location and maintenance accessibility of the wireless telecommunications facilities so that the safety of the adjacent highway is not compromised. In addition, MoDOT will be responsive to the aesthetic impacts that wireless facilities may have on adjacent property. After extensive negotiations, the original communications company

selected by MoDOT decided not to pursue this partnership further due to changes in the wireless telecommunications market. MoDOT will continue to seek other partners for future opportunities in resource sharing.

Commercial Vehicle Operations

ITS/CVO Mainstreaming Program

MoDOT is participating in the FHWA ITS/CVO Mainstreaming program and is serving as the lead state for the Midwest ITS/CVO Mainstreaming consortium which includes South Dakota, Kansas, Iowa and Nebraska. Each state has formed working groups that include representation from all state agencies that are involved in the regulation of commercial vehicles, the FHWA Division Office of Motor Carriers, and the Motor Carrier industry. The Mainstreaming program includes development of a strategic business plan for each state participating in the consortium which will provide a foundation to facilitate nationwide deployment. The Missouri business plan was completed in May, 1998. A draft of the regional business plan has also been completed and is to be finalized in September, 1998. An electronic screening prototype which includes credential approval, safety check and weigh-in-motion is planned to be operational in the Joplin area by early 1999.

Operational Test - Multi-State One Stop Electronic Purchase of Motor Carrier Credentials

This project involves designing and beta testing a simple, lowcost, and easily deployed one-stop electronic service system which will allow motor carriers to receive all the necessary credentials or permits electronically from a base State or other individual States. The operational test included six motor carrier firms and seven states, including Missouri. Operational testing was initiated in May, 1997 and was completed on October 31, 1997. Early evaluation data indicate that development of the system helped to establish nationwide EDI standards for electronic one-stop shopping functions. Also,

testing of the system demonstrated to the states and motor carriers the feasibility of utilizing electronic processes for establishing credentials and permit activities. Information obtained from this operational test has been incorporated into Missouri's strategic business plan to facilitate future implementation.

Missouri Completes First High Performance Concrete Prestress I-Girder Fabrication

In 1996, Missouri volunteered to participate as a lead state in the AASHTO Lead State Program for High Performance Concrete. The lead state program was initiated in 1996 by the AASHTO Task Force on SHRP Implementation in an effort to implement specific "high payoff" SHRP technologies such as high performance concrete. High performance concrete (HPC) technology utilizes innovative design and construction concepts for improved pavements and bridges. As a result, pavements and bridges are constructed having longer service lives with improved performance and greater economic benefits. As a lead state in HPC technology, Missouri is committed to help further the development and implementation of HPC.

Project Description:

Missouri recently completed the fabrication of the state's first high performance concrete (HPC) prestress I-girders. The HPC I-girders were fabricated by Egyptian Concrete Co. in Bonne Terre, Missouri and will be used in the 4-span, Route 21 N.B.L. bridge over Route M in Jefferson County. A design strength of 10,000 psi at 56 days in the prestress I-girders was used as opposed to a 5000 psi design strength typically used. As a result of the increased strength, the bridge requires only five girders per span instead of six, with the spacing between the girders increasing from 8'8" to 10'10". Construction of a companion structure, the Route 21 S.B.L. bridge over Route M, which utilizes conventional concrete in the prestress I-girders will allow comparison of the durability and in-service performance of the HPC I-girders versus the conventional mix I-girders.

Fabrication:

Fabrication of the HPC prestress I-girders went as scheduled with minimal problems. Even though casting took place during some of the hottest temperatures of the summer, the fabricator was able to maintain controlled temperatures throughout operations by scheduling early a.m. pours, using chilled water, shaded aggregates, and fabricating in a housed environment.

The HPC mix, using Type I cement with silica fume and having a low design water-to-cementitious material (W/CM) ratio of 0.240, produced strengths well over 10,000 psi. Strengths up to 11,500 psi at 3 days were reported. The addition of a high range water reducer (HRWR) to the mix enabled the fabricator to maintain the low W/CM ratio while producing a mix that was workable and placeable. The mix was also air-entrained with air contents averaging 5.4% throughout fabrication. Tighter specifications, minimizing allowable tolerances and necessitating excellent quality control, and a cooperative effort between the fabricator and representatives from W.R. Grace, River Cement Company and MoDOT made for an overall successful operation.

Project Research:

Research on the HPC project has been a joint effort between MoDOT and the University of Missouri at Columbia (UMC). Project research includes laboratory testing of specimens collected during fabrication, as well as, instrumentation and monitoring of the I-girders immediately following casting and while in-service. Laboratory testing includes the following:

- compressive strength up to 1 year
- creep
- shrinkage
- modulus of elasticity
- rapid chloride permeability
- freeze-thaw durability
- air-void analysis

Instrumentation of the I-girders for strain and temperature data will provide information concerning the general behavior of HPC prestress I-girders and its creep, shrinkage, and thermal effects on prestress losses over time.

Test specimens have also been collected during fabrication of the prestress I-girders using conventional concrete also produced by Egyptian Concrete Company. Laboratory testing will include the same testing as that for the HPC specimens. Actual comparisons can then be

made to determine the extent of enhancements in HPC versus conventional mix.

After complete construction of both the bridge with the HPC I-girders and the companion bridge with the conventional I-girders, a field performance program will be initiated to monitor and compare the performance of the structures on an on-going basis

Project Costs and Benefits:

The use of HPC in the I-girders eliminated one girder line in the bridge superstructure which saved in the fabrication of twenty I-girders instead of twenty-four. As expected, the initial costs of the HPC I-girders per linear foot were higher (approximately 39%) when compared to the cost of the conventional I-girders. This increased initial cost may not only be attributed to the increased

cost of producing a higher quality mix, but also due to the fact that it's a new technology which would appear to pose some risk. Overall benefits of the HPC, though, should be demonstrated by the significant long term savings produced as a result of its improved durability and less maintenance and repair required over a longer service life. In addition, this project proved that HPC in structures is an viable concept in Missouri, and that it has much potential for improving Missouri's bridge design and construction methods.

Contact:

If you would like further information, please contact:

Patty Brake Lemongelli
Phone: (573) 526-4328
Email: brakep@mail.modot.state.mo.us

Research Investigation R197-015 September, 1998

Missouri High Performance Concrete Update

Fiber-reinforced PCC Unbonded Overlay I-29 Atchison County

In 1996, Missouri volunteered to participate as a lead state in the AASHTO Lead State Program for High Performance Concrete. The lead state program was initiated in 1996 by the AASHTO Task Force on SHRP Implementation in an effort to implement specific "high payoff" SHRP technologies such as high performance concrete. High performance concrete (HPC) technology utilizes innovative design and construction concepts for improved pavements and bridges. As a result, pavements and bridges are constructed having longer service lives with improved performance and greater economic benefits. As a lead state in HPC technology, Missouri is committed to help further the development and implementation of HPC.

Project Description

July 1998 saw the completion of the first section of fiber-reinforced concrete pavement in the state of Missouri. The section, an unbonded fiber-reinforced concrete overlay, is located in the southbound lanes of I-29 in Atchison County between Route A and US 136. Within the total length of over four miles, eight 2500' test sections have been established. Three of the test sections are reinforced with steel fibers and are 9", 6" and 5" thick. Another three test sections, also 9", 6" and 5" thick, are reinforced with polyolefin fibers. The two remaining test sections will serve as control sections and are non-reinforced jointed concrete overlays at 9" and 11" thick. Joint spacing in the fiber-reinforced test sections varies from 15' to 200' and the joint spacing in the non-reinforced sections is 15'.

MoDOT, in cooperation with the University of Missouri - Columbia, previously completed a laboratory evaluation of fiber-reinforced mixes incorporating several fiber types at varying dosage rates. Based on toughness test results from this study and manufacturer's recommendations, the following two fibers were chosen for the I-29 overlay:

- 3M 50mm polyolefin fibers at a dosage rate of 25 lbs./cu. yd.
- Bekaert 60mm steel fibers at a dosage rate of 75 lbs./cu. yd.

Construction

The concrete paving contractor for the project was Cedar Valley Corp. of Waterloo, Iowa. The original 9" reinforced PCC pavement received pavement repair and a 1" asphalt debonding layer. The fiber-reinforced concrete overlay mix had an average water to cementitious materials ratio of 0.39 and Bethany Falls limestone coarse aggregate of a 1/2" maximum gradation. The ratio of fine aggregate to coarse aggregate was 45/55.

Non-uniform distribution of fibers in the concrete was observed at times during construction. This condition existed with both fiber-reinforced mixes, but was observed more frequently in the polyolefin fiber-reinforced sections than in the steel fiber-reinforced sections. Mixing times were increased and the order of mixer loading was altered to address this concern. Both solutions seem to increase uniformity of the fiber distribution in the concrete.

(Continued on next page)

(continued from page 5)

In lieu of the conventional transverse tining texturing methods, the contract required diamond grinding of the overlay 21 days after construction for smoothness and rideability. Interim finishing required a burlap drag. It was discovered during construction that a better finish could be achieved with an unweighted carpet drag rather than the burlap drag. The fibers became caught in the burlap which led to some fibers and aggregate being pulled from the top layer of the overlay. The carpet drag remedied the problem. Following grinding, profilograph readings averaged less than 11 in./mile on the new overlay using a zero blanking band which resulted in a contract bonus.

Project Research

Research on the fiber-reinforced concrete is a joint effort between MoDOT and the University of Missouri - Columbia. Project research includes laboratory testing of specimens collected during paving and monitoring pavement performance through field distress surveys. The laboratory testing will be performed on both the fiber-reinforced concrete and the non-reinforced concrete and will include the following:

- 7 and 28 day compressive strength
- 7 and 28 day flexural strength
- toughness testing
- fatigue endurance

Pavement distress surveys have been completed for 1 day, 2 weeks and 1 month after construction. Additional distress surveys are scheduled for 3 months, 6 months, 1 year and periodically

throughout the pavement service life to provide a history of performance.

Nearly no cracks have appeared in the non-reinforced concrete sections. It should be noted, however, these sections were constructed with 15' joint spacings. In comparison, the 15' and 30' panels in both the steel and polyolefin fiber-reinforced sections also experienced nearly no cracks.

Initial performance results of the fiber-reinforced sections are positive. Both the polyolefin and steel fiber-reinforced sections have experienced some cracks in the 60' and 200' panels, with the polyolefin sections showing fewer cracks than the steel sections. Inclusion of reinforcing fibers in the concrete should lead to improved post-crack performance of the overlay, extending the pavement's useful service life.

Project Cost

The long term advantages of an extended service life, requiring less maintenance, and the possibility of constructing a pavement which is thinner and requires less material than the current practice should offset the additional cost of including reinforcing fibers in the concrete. The additional cost over conventional concrete for the steel fiber-reinforced concrete was \$47.00/cu. yd. and \$60.00/cu. yd. for the polyolefin fiber-reinforced concrete. A cost per mile comparison between the non-reinforced control sections and the 5" fiber-reinforced sections is shown below.

11" Non-reinforced	(4302 cu. yd./mi.) (\$79.00/cu. yd.) = \$340,000/mi.
9" Non-reinforced	(3520 cu. yd./mi.) (\$78.96/cu. yd.) = \$278,000/mi.
5" Polyolefin fiber-reinforced	(1956 cu. yd./mi.) (\$136.76/cu. yd.) = \$268,000/mi.
5" Steel fiber-reinforced	(1956 cu. yd./mi.) (\$123.62/cu. yd.) = \$242,000/mi.

The numbers shown above represent the cost for furnishing and placing a 24' wide overlay and does not include any repair of the existing pavement, debonding layer or diamond grinding.

Contact:

If you would like further information, please contact:

Tim Chojnacki

Phone: (573) 751-1040

E-mail: chojnt@mail.modot.state.mo.us

Final Report RDT 97-4

Longitudinal Restraint Response of Existing Bridge Bearings

Description:

A six month study was conducted for the Missouri Department of Transportation (MoDOT) by the Department of Civil Engineering at the University of Missouri-Columbia to test steel pin bridge roller bearings for longitudinal restraint behavior. The purpose of the tests was to examine the energy dissipation capabilities and the load-deformation characteristics of roller bearings to determine if existing bearings may be utilized in seismic retrofitting of earthquake susceptible bridges.

All-American Shouldering Disc

Description:

In 1996, the Missouri Department of Transportation (MoDOT) purchased two All-American Shouldering Discs for District 4. In 1997, four All-American Shouldering Discs were purchased for District 2. This piece of equipment is used to reduce edge drop-offs and improve shoulder slopes in the spring and fall of the year when the soil is moist. They are attached to a large tractor with a 55 PTO horsepower minimum.

Advantages/Disadvantages:

The All-American Disc will remove the berm from the point of the shoulder that hinders water drainage and grind sod into small pieces. The disc eliminates the problem of your Motorgrader bringing large chunks of trashy sod up and onto the roadway. It is estimated, at least 50 cubic yards of material is reclaimed per mile. This practice will reduce edge drop-off and improve shoulder cross slopes, which will reduce tort liability. It is six times faster than the conventional Motorgrader usage, making it more cost effective and provide a wider coverage of service.

The disadvantages of the All American Disc is that it requires a larger tractor of which there are only a limited number and its use is only seasonal, spring and fall.

Cost:

A cost analysis has been calculated for the all-American Disc and compared to the Motorgrader.

*The cost per day using the All-American Disc is \$527.24. The cost per day for using Motorgraders is \$551.14 (the major saving is found in cost per mile).

*The average accomplishment for the All-American Disc is 30 miles compared to 5 miles for the Motorgrader.

*The cost per linear mile for the Disc method is \$16.69 compared to the cost of \$104.21 using the Motorgrader method, which translates into a savings of \$87.52 per mile utilizing the All-American Disc.

Conclusions:

The All-American Disc is a tool that will allow you to eliminate all edge drop-offs on soil or aggregate shoulders in the spring and fall of each year. This will be cost effective and will reduce tort liability which MoDOT may be exposed to. Details of the report and equipment specifications are now available.

Contact:

Ivan Corp
Missouri Department of Transportation
Phone: 816-889-6403
Email: corpi@mail.modot.state.mo.us

Don Davidson
Missouri Department of Transportation
Phone: 573-751-4620
Email: davidd1@mail.modot.state.mo.us

Procedure:

Sixteen bridge bearings were tested to determine their response to vertical and simulated longitudinal loads. Four bearings were tested to determine the ultimate load-deformation characteristics. The ultimate bearing tests showed that all four bearings were able to move over five inches longitudinally prior to zero load instability.

Advantage:

Existing bearings can be used in seismic retrofitting, which will be more cost effective than total replacement.

Results:

Manufacturers and designers are currently conducting further investigations to verify the study results. It is anticipated that future designs will incorporate existing bearings in seismic retrofitting of bridge structures.

Contact:

Michael Barker, P.E.
Associate Professor of Civil Engineering
University of Missouri-Columbia Civil Engineering Department
E2509 Engr. Bldg. East
Columbia, MO 65211, or
Keith McGowan
Missouri Department of Transportation
1611 Missouri Blvd., P.O. Box 270
Jefferson City, MO 65102
(573) 751-4641

Missouri Department of Transportation
Technology Transfer Assistance Program
Local Technical Assistance Program
P.O. Box 270
Jefferson City, MO 65102

Telephone
573-751-0852

Address Correction Requested



The Missouri Transportation Bulletin is published by the Technology Transfer Assistance Program of the Missouri Department of Transportation, Jefferson City, Missouri. The opinions, findings or recommendations expressed in this Bulletin are not necessarily those of MoDOT or the Federal Highway Administration.

Editor: Jim Radmacher
Assistant Editor: Theresa Berendzen
Missouri Department of Transportation
1617 Missouri Blvd.
P.O. Box 270
Jefferson City, MO 65102 phone: 573-751-0852